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(54) **Apparatus for decorating ceramic and glass substrates and toner powder for use in such apparatus**

(57) Apparatus for printing ceramic or glass flat plates, wherein a fusible powder is applied to an image forming medium in order to form an image and transferred to an intermediate medium, the powder image on the intermediate medium being brought into contact with

the substrate in a contact zone, the ceramic or glass substrate being heated in a pre-heating device before the contact zone to a temperature of at least 60°C, and wherein the intermediate medium in the contact zone is heated to a temperature of at least 100°C.

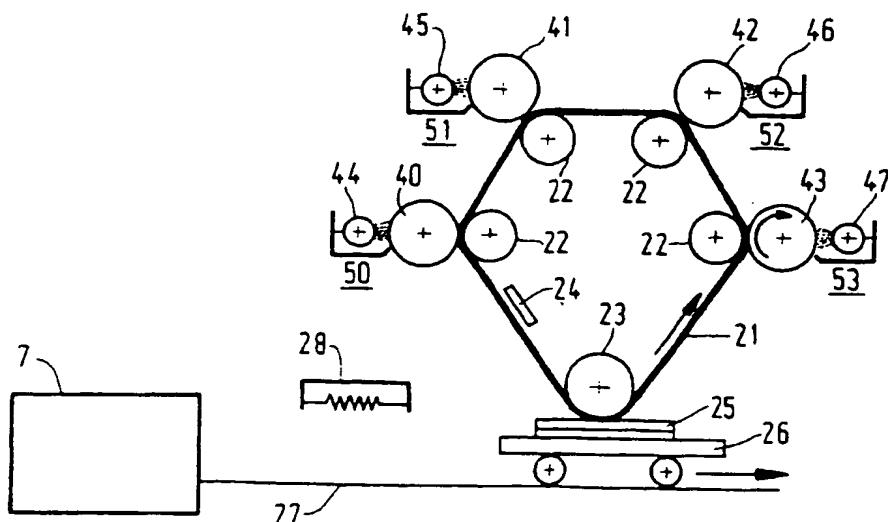


FIG. 2

## Description

The invention relates to an apparatus for decorating ceramic and glass flat plates and toner powder for use in such apparatus. Flat plates or substrates of this kind are processed in an apparatus in which the substrates are moved from one processing station to another and are provided with a print in one of the processing stations. In conventional processing stations for decorating ceramic and glass substrates, use is made of a screen printing apparatus, for example. For this purpose, a screen has to be made for each series of substrates in order to print the same. In the case of multi-colour printing, more of these screens are required.

Making the required screens in this way is extremely complicated and expensive and obstructs rapid change of substrates with different prints. The processing machines have to be stopped for each new image in order to replace the screens and re-start the process.

The decoration of ceramic and glass substrates can also be carried out in accordance with EPT 0 647 885, wherein an electrophotographic method is used to make an intermediate original, e.g. a paper substrate covered with gum Arabic, the intermediate original subsequently being brought into contact with the substrate. The toner image applied to the intermediate original is then transferred to the ceramic or glass substrate in a manner similar to the decalcomania process. The transferred image is then fired into the substrate at high temperature. This method requires considerable manual labour and is time-consuming. The object of the invention is accordingly drastically to reduce the above disadvantages.

To this end, according to the invention, use is made of an apparatus for printing ceramic or glass substrates, wherein a fusible powder is applied to an image forming medium in order to form an image and transferred to an intermediate medium, the powder image on the intermediate medium being brought into contact with the substrate in a contact zone, the substrate being heated in a pre-heating device before the contact zone to a temperature of at least 60°C, and wherein the intermediate medium in the contact zone is heated to a temperature of at least 100°C. As a result, different images can be applied to the image forming medium in rapid succession and these images can be transferred to the ceramic or glass substrates without stopping the processing machine, thus increasing the machine productivity and providing bonding between the transferred images and the substrates. High quality mechanically resistant decorations are obtained if the image is fired in the ceramic or glass substrate.

The invention will be explained hereinafter with reference to a number of drawings, from which these and other advantages will be apparent. Fig. 1 is a diagram showing an apparatus according to the invention and Fig. 2 is a diagram showing apparatus according to the invention for printing recording substrates in colour, the substrates being in the form of discs.

Fig. 1 diagrammatically illustrates an apparatus according to the invention. A rotatably mounted image forming medium 20 provided with an electrophotographic layer is provided with a uniform charge at charging station 30, said charge being exposed image-wise, for example with a laser, in exposure station 31. The remaining charge image is provided with a fusible powder in developing station 32. This powder image is transferred to an intermediate medium 21 by contact therewith. The intermediate medium 21 is formed by a flexible belt provided with a top layer of silicone rubber and supported by transport rollers 22 and 23. The intermediate medium 21 with the powder image thereon is so heated by means of a heater 24 that the powder on the medium level with the transport roller 23 is in the molten state. It is also possible for the transport roller 23 to be provided, in manner known to the skilled man, with a heating device (not shown) for melting the powder image 29. The holder 26 is provided with transport means which bring the substrates into contact with the powder image 29 on the intermediate medium 21 via a transport path 27. The temperature of the intermediate medium 21 is at least 100°C in the contact zone. Before contact the substrate is heated in a preheater 28 to a temperature of at least 60°C.

The melted powder image 29 is transferred to the substrate in the contact zone. After the toner image has been completely transferred, the substrate is transported via the transport path 27 to a discharge station (not shown). The apparatus is provided with synchronisation means (not shown) which ensure that the powder image recorded and developed on the image forming medium 20 is formed in register with the substrate passing in the contact zone.

It is clear that other image forming techniques can be applied to form a powder image on the image forming medium 20. A suitable technique, for example, is the inductographic technique as described in European Patent 0 191 521. In this, the drum on which the image-forming medium 20 is located is replaced by a drum provided with a series of electrodes insulated from one another and extending on the periphery of the drum and capable of being fed with a voltage image-wise by means of trigger electrodes, said electrodes then being provided with an image-wise powder image by means of a developing station 32 suitable for the purpose.

Fig. 2 diagrammatically illustrates apparatus according to the invention for the multi-colour printing of substrates by the inductographic principle. The reference numerals used in Fig. 1 are maintained here for like functions or parts. Four image forming media 50 - 53 are shown around the intermediate medium 21 in the form of a belt and are each provided with an inductographic drum 40 - 43 and a developing device 44 - 47. The developing devices 44 - 47 are each provided with a toner in a separate colour, e.g. cyan, magenta, yellow and black or red, yellow, blue and white. The drums 40 to 43 are provided with electrodes extending around the

drums in a dielectric layer and are so triggered that the colour separation images formed on these drums are transferred in register to the intermediate medium. The colour image thus formed by fusible toner powder on the intermediate medium 21 is then again heated by heater 24 and transferred to the passing substrate 25. It is clear that any required number of image forming devices can be used and that they can be provided with the required colour toner in order to obtain the required colour image on the ceramic or glass substrate.

The image-wise triggering of the image forming devices according to Figs. 1 and 2 can be effected by means known per se. It will generally be effected via a computer or image make-up station on which an image can be made up and the data required for the image are transferred to the image forming devices.

In this way it is possible to give each of the substrates a different print as required rapidly and simply.

In the examples indicated, the intermediate medium is a flexible belt provided with a top layer of silicone rubber, but of course it is possible to use a rotatable drum for the purpose and to provide it with silicone rubber. The image forming devices should then be located in accordance with this construction. In order to bring the intermediate medium 21 to the required temperature in the transfer zone, the heater 24 can be disposed in a metal transport roller 23.

A powder consisting of a thermoplastic resin and ceramic pigments can be used as the fusible powder or toner powder. Ceramic pigments are substances which retain their colour at very high temperatures and which can be fired in ceramic or glass substrates in order to decorate the same. The ceramic pigments will generally be inorganic colour pigments, such as metal oxides (e.g. ZnO, TiO<sub>2</sub>, CoO, Al<sub>2</sub>O<sub>3</sub>, Cr<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub>) and metal silicates, e.g. zirconium silicates with incorporated vanadium, praseodimium or lead and compounds such as cobalt aluminates and mixtures of these pigments. The thermoplastic resins may be any resins suitable for the purpose, e.g. styrene acrylate resins, polyesters, polyamides, polyurethane, epoxy resins and mixtures of these resins. Also, depending on the developing method, magnetic pigments may be added to the resin and the powder particles can also be provided with electrically conductive material, e.g. carbon black, conductive polymers and conductive tin oxides.

It is advantageous to prevent the above mentioned magnetic pigments from being oxidised during the fusing of the toner powder, by fusing the toner powder in an inert atmosphere or by providing a protective coating on the pigments.

The ceramic and glass flat plates are used inter alia as hot plates, tiles and the like.

wherein a fusible powder is applied to an image forming medium in order to form an image and transferred to an intermediate medium, the powder image on the intermediate medium being brought into contact with the substrate in a contact zone, the ceramic or glass substrate being heated in a pre-heating device before the contact zone to a temperature of at least 60°C, and wherein the intermediate medium in the contact zone is heated to a temperature of at least 100°C.

- 5 2. Apparatus according to claim 1, wherein the recording substrate in the form of a disc is heated to a temperature of 60 to 100°C and the intermediate medium in the contact zone is heated to a temperature of 100 - 140°C.
- 10 3. Apparatus according to claim 1 or 2, wherein at least three image forming media are provided, each image forming medium being provided with a powder image with fusible powder of a different colour and wherein said powder images are transferred to the intermediate medium.
- 15 4. Apparatus according to claim 3, wherein the powder images of all the image forming media are transferred to the intermediate medium in register.
- 20 5. Apparatus according to any one of the preceding claims, characterised in that the intermediate medium is formed by a flexible belt provided with a top layer of silicone rubber.
- 25 6. Apparatus according to claim 5, wherein the belt in the contact zone is trained over a metal roller provided with heating means.
- 30 7. Apparatus according to any one of the preceding claims 1 to 6, wherein a fusible powder contains a thermoplastic resin and ceramic colour pigments.
- 35 8. Apparatus according to claim 7, characterised in that magnetic pigment and electrically conductive material is added to the fusible powder.
- 40 9. Toner powder for use in an apparatus according to any one of the preceding claims, characterised in that the toner powder contains a thermoplastic resin and ceramic colour pigments.
- 45 10. Toner powder according to claim 9, characterised in that magnetic pigment and electrically conductive material is added to the thermoplastic resin.

## Claims

1. Apparatus for printing ceramic or glass flat plates,

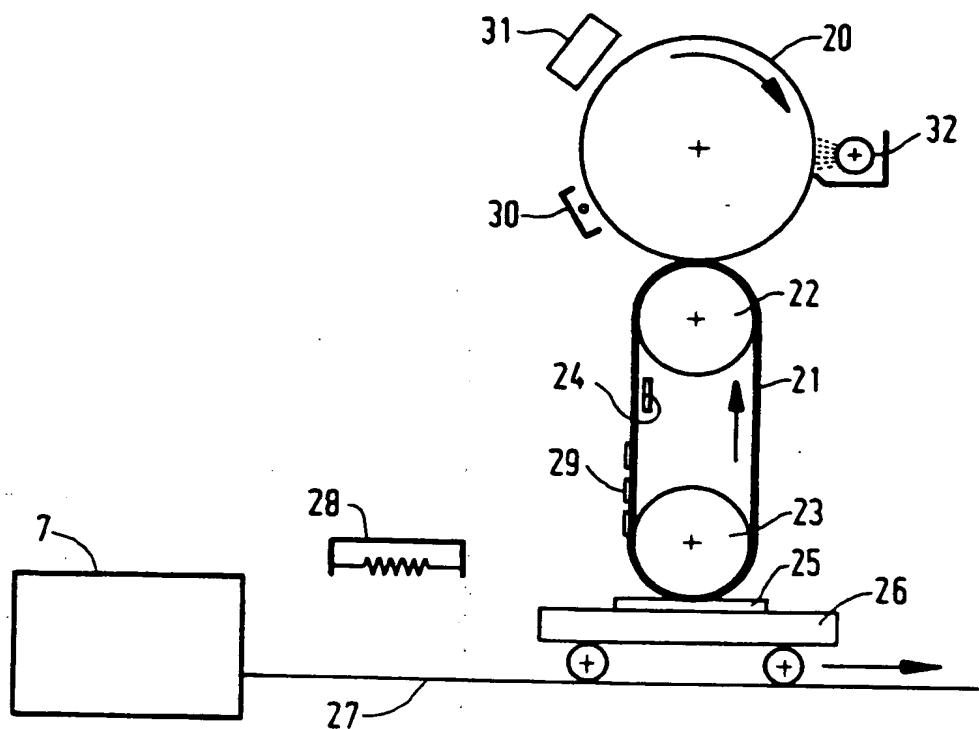


FIG. 1

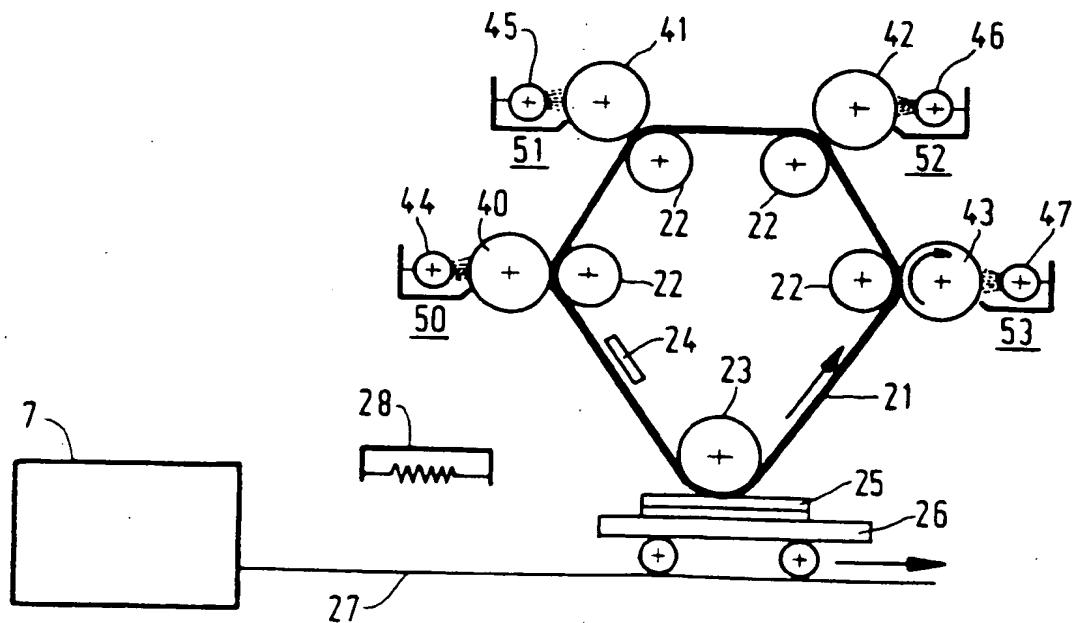


FIG. 2



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## EUROPEAN SEARCH REPORT

Application Number  
EP 97 20 2953

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
Y	WO 94 15263 A (BYGRAVES ANTHONY ERIC ;PORTER ALAN BRIAN (GB); MABBOTT ROBERT JOHN) 7 July 1994 * claims *	1-6	G03G15/16 B41M1/34
Y	PATENT ABSTRACTS OF JAPAN vol. 008, no. 254 (P-315), 21 November 1984 & JP 59 125766 A (KONISHIROKU SHASHIN KOGYO KK), 20 July 1984, * abstract *	1-6	
D,A	EP 0 647 885 A (ZIMMER MICHAEL) 12 April 1995 * the whole document *	1,9,10	
A	GB 2 238 985 A (ROYAL DOULTON) 19 June 1991 * page 7, last paragraph - page 10, paragraph 1; claims; figures *	1	
A	US 4 187 774 A (IWASA MASAKAZU ET AL) 12 February 1980 * the whole document *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G03G B41M
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	6 January 1998	Lipp, G	
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T : theory or principle underlying the invention E : earlier patent document, but published on or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			